Nutritional Evaluation of Weaning Food Produced From Combination of Rice, Corn and Sorghum Flour Blends

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Abstract:
The use of rice, sorghum and corn flour blends in the formulation of low cost nutritive weaning foods diet were studied. The weaning food samples were analyzed for their nutritional, functional and sensory properties. The nutritional composition of the samples showed that the carbohydrate content increased with increasing inclusion of rice flour. The functional properties of the samples showed an increase in the swelling index and water absorption capacity from diet I to diet III while bulk densities were relatively constant. The sensory evaluation carried out on weaning food samples after reconstituting into gruel with warm water, milk, glucose showed that all the samples were well accepted by the judges. The results of the proximate composition showed that there was no significance difference in the protein contents of the weaning food samples. The result indicates that sample C has the lowest moisture content and therefore will have high storage stability. The fat composition of the weaning food showed that the samples have low fat contents. The carbohydrate contents of the weaning food showed that there is high level of carbohydrate contents amongst the samples. It is therefore recommended that substituting up to 10% protein to the weaning food will enhances its nutritional composition
Keywords: *Evaluation, weaning, Nutrition Sorghum and flour*

Introduction

The term 'weaning' comes from the word 'weanian' which means to accustom or process of introducing semisolid food into the infant diet in addition to milk (Encyclopedia of food science and technology and nutrition). It is the process of gradually introducing a mammal infant to what will be its adult diet and gradually withdrawing the supply of its mother`s milk. The process takes place only in mammals, as only mammals produce milk. The infant is considered to be fully weaned once he/she no longer receives any breast milk (of bottled substitute). This weaning period is a crucial period in the infant`s life. At the age of 5-6 months; most infants begin to eat supplementary semisolid foods. At this stage homogenized infant foods play a major role in their nutrition). Weaning food for a child in a developing country like Nigeria where food are relatively expensive is out of reach of a majority of the people and may result in malnutrition and pose a risk to the life of a child particularly if the parents are low-income earner. Most food commonly sold in Nigeria are composed mainly of cereal grains which contribute about 42% of the total daily calories and 49% of the total daily protein (Muller, Garenne, Kouate and Becher, 2003). The maize (corn), based products are usually in the form of porridges such as pap. Wet sieving and steeping have considerable effects on the protein losses in pap resulting in pap being poor food for infant (Nnam, 2002). This loss of an appreciable proportion of original nutrient content of pap during its production has led to the development of soy pap. Soybean is often in short supply in some regions and out of reach of low-income population; this has led to an increase in the cost of production of soy-based food, therefore reducing its affordability (Edema, Sanni, 2005). Thus, the need to provide a low-cost nutritious supplement for infants cannot be overemphasized. (Solomon, 2005) argues that malnutrition during infancy permanently changes the body`s structure physiology and metabolism leading to coronary heart disease and stroke later in life. There is therefore the need to explore the nutritional potential of affordable, alternative carbohydrate and protein based food crops such as cooking banana (musa sp) and legumes. How infants are fed appears to influence their long-term development and health (Mahguob, 1999). Thus, heightening the importance of improving infant food. A study of growth of infant along with parallel estimations of the output and chemical composition of the milk of the mother has shown that even infants from socio-economic background can grow normally during the first four months of life on milk of their mothers, but mother`s milk soon show a small deficit in energy prior to the sixth month (Sawyer, Ordinioha & Abuma, 2013).

At this stage, it becomes nutritionally necessary to introduce iron-containing foods, since that is the time the stores from birth are being diminished; their requirement from this age exceeds the supplies of human milk. An additional source of protein becomes important towards the end of the first year of life because the gram of protein per kilogram of body weight supplied by milk drops as the infants grows (Takyi, 1991, Svanberg, 1991 and Morely 1998).

Statement of problem

Malnutrition has been an important factor in determining the level of poverty and livelihood(Opara, Adebola and Oguzor,2011).Problems of malnutrition in children and rural women especially child bearing mothers have continued to be critical in most developing countries. This problem associated with inadequate protein and amino acids supply to the growing child. Results in several form of malformation ranging from Kwashiorkor, Marasmus, stunting, wasting and so on. Malnutrition and poor growth during infancy affect a large portion of the world`s population; more than 800 million children under 5 years of age suffer from malnutrition and growth failure. Such morbidity is responsible for more than 10 million deaths per year in this age group. Malnutrition groups for the higher infant mortality rate in (95/1000 live births) compared to that in developed countries 'solid first step 2010' several types of supplementary foods are being marketed in Nigeria. Some are nutriend, cerelac, golden morn, they contains about 14% protein and are nutritionally balanced most of these baby foods being nutritious blends of cereals, legumes and milk, are excellent supplements to child milk food and they are convenient to feed also. But they are quite expensive and are beyond the purchasing power of the parents belonging to middle and lower groups. Due to this, parents belonging to lower income strata feed their own children with foods that adults eat through factors in the mother saliva. However, food from caregivers of lower socioeconomic status in areas of endemic diseases can result in passing the disease to the child.

The aims and objectives of this research are:

I. To formulate a weaning food that would be nutritionally adequate, culturally acceptable, cheap and easily available.
II. To evaluate the chemical composition and nutritive value of the infant weaning foods formulated from locally available staple grains and cereals.
III. To compare the effect of the weaning food formulated with a known nutrient, commercially produced weaning food like Nan and SMA as control diet.

The need for weaning foods that meet the nutritional requirements of the infants in both developed and developing countries is achieved through commercially produced weaning foods prepared by extrusion or roller drying processes. However, the products are marketed are too expensive for the target groups who need such a product in developing countries it is therefore desirable to study ways and means of developing less costly but equally nutritious weaning foods that may be within the reach of the wider population. This research project is geared towards achieving that.

Food industries could also utilize the information by developing cheaper weaning foods using locally grown crops, which will help to meet the nutritional requirement of weaning. The information collected can also be of benefit to nurses, dieticians, doctors and nursing mothers.

Research Questions

1. How can weaning food be produced from a combination of corn, rice & sorghum flour.
2. How can the chemical composition & nutritive value of the infant weaning food formulated from (i) above be evaluated.
3. How can the formulated weaning food from (i) above be compared with a known commercial foods like Nutrient.

This research covered the production of weaning food from composite flours of rice, sorghum and corn. The weaning food produced were subjected to chemical analysis to determine their proximate composition functional properties while the acceptability of the weaning was determined using sensory evaluation.

The study used experimental design.The sorghum was bought from Ariaria main market Aba. Yellow maize and rice were both purchased from Ubani main market Ibeku Umuahia. While the Nutriend used as a control was purchased from family supermarket, Umuahia.

Materials and methods

Preparation of Sorghum Flour

Sorghum (white variety) were sorted, winnowed, cleaned and weighed. The required quantities of sorghum were dry milled, sieved and flour packed into a polythene bag.

Flow Chart For The Preparation Of Sorghum Flour

Sorghum Grains
↓
Sorting
↓
Cleaning
↓
Weighing
↓
Parboiling
↓
Dry Milling
↓
Sieving
↓
Sorghum Flour
↓
Package (Polythene Bag)

Flow chart for the preparation of maize flour, the yellow variety of maize grains were utilized in the preparation and formulation of the infant weaning diets. The grains were inspected cleaned, winnowed and any rotten grains or unwanted materials were removed, the clean grains were dry milled and sieved to obtain maize flour.

Maize Grains
↓
Sorting
↓
Winnowing
↓
Cleaning
↓
Weighing
↓
Parboiling
↓
Dry Milling
↓
Sieving
↓
Maize Flour

Flow Chart for Preparation of Rice Flour

Rice Grains

↓
Sorting
↓
Winnowing
↓
Cleaning
↓
Weighing
↓
Parboiling
↓
Oven Dry
↓
Dry Milling
↓
Sieving
↓
Rice Grains

Sample Formulation: The ingredient used for this experiment are sorghum, rice & corn flour different experiment diet were formulated and labelled D1 D2 D3 and D0 (as control). With varying levels of sorghum rice and corn. A total of 100g per diet were formulated based on crude protein requirement of weaning baby according (Akandu, 1998) who reported a 16% crude protein requirement of a weaning baby.

Sample of the Study

The yellow variety of maize (zea mays) rice and sorghum (sorghum bicolour). Glucose stabilizer (skimmed milk), vanilla flavour, banana flavour sweetener were the raw material used for the preparation and formulation of the infant weaning diets other materials used for the feeding experiment is Nutriend manufactured by Nestle foods Plc, Lagos, Nigeria as a control.

Proximate composition

The composition of food is an analysis of level of moisture, ash, protein, crude fat or ether extract, crude fibre and carbohydrate. The proximate composition of rice, maize and sorghum flour and the entire composite blend were analyzed using the standard official methods of analysis of association of official analysis.

This was determined using the gravimetric method reported by James (1993) chemist A.O.A.C (1990).

Determination of Moisture Content

30g of each of the sample were placed into different empty dry silica dishes of a known weight and samples were dried in the oven at a temperature of about 86ºC-100ºC, until a constant weight was obtained after three hours. Duplicate determinations were made and the weight difference which is due to moisture loss was expressed as percentage of the weight of the sample.

$$\textbf{\% moisture} = \frac{\textbf{loss in weight}}{\textbf{Initial weight of sample}} \times \frac{\textbf{100}}{\textbf{1}}$$

$$\frac{W_2 - W_3}{W_2 - W_1}$$

Where
W_1 = weight of empty silica dish
W_2 = weight of silica dish + sample before drying

W_3 =weight of silica dish + samples constraint weight
Determination of Crude Protein

This analysis was carried out using the semi-micro kjeldahi distillation methods, describe by (James, 1995).

a. **Digestion of Sample**
3g of food samples were weighed into a kjeldahi digestion flask and also a kjeldahi catalyst (consisting of a concentration of 3.5% copper sulphate, 96% anhydrous sodium sulphate and 0.5% selenium dioxide were added. 15ml of concentrated $H_2\ SO_4$ was added through a burette into kjeldahi apparatus at a temperature of 400°C and allowed for complete digestion to occur. The kjeldahi apparatus was connected to a flask containing a solution of NaOH to trap the volatile choking odour released during the digestion until a clear solution is obtained. The digest were then allowed to stand for some time for cooling to take place.

b. **Distribution of Sample**
The digest were transferred into a volumetric flask and made up to 50ml with distilled water. 10ml of each of the digest were collected via a pipette and added into a semi-micro kjeldahi distillation unit and ammonia being liberated was distilled over into a flask containing 10ml of boric acid **mixed with 3 drops of universal indicator.**

c. **Titration of Samples**
The distillate obtained was then titrated with 0.02ml $H_2\ SO_4$ solution to facilitate the release of nitrogen and the end point was obtained when the colour of the distillate changed.

The result was calculated as shown below;

1 mole of $NH_2\ SO_4$	= 14gmN				
1 mole of 0.02 $NH_2\ SO_4$	= 0.02 x 14				
	= 0.28mg/N				
10ml of distilled digest	= 100ml		10ml	= 10	
3g of sample used	= 100ml	33.3		3g	

By the kjeldahi method the percentage nitrogen is calculated

Thus: %nitrogen = $\frac{\mathbf{0.2 \times 100 \times 100 \times 1}}{\mathbf{10 \quad 3 \quad 10^3}}$

Where x = titre value
Note: $1/10^3$ is used for converting the % nitrogen value to grammes.
There % crude protein= % nitrogen x 6.24 (kjeldahi factor) and the AOAC (1984) furnace incineration gravimetric method.

Determination of AS Content
This method was described by Pearson (1976) as the inorganic residue remaining after the organic matter has been lighted and burnt away. 3.0g of each of the sample were weighed into clean crucibles of known weight. The sample were placed in a multiple furnace at a temperature of 600°C for 3hrs all the organic constituent were
Percentage ash was calculated as

$$\textbf{\% ash} = \frac{\textbf{Weight of ash x 100}}{\textbf{Weight of sample 1}}$$

Crude Fibre determination
30g of each of the samples were transferred to an extraction apparatus and extracted with light petroleum ether by continuously storing, setting and decanting. The extracted sample is transferred to a dry 100ml conical flask and 200ml of 0.2 $NH_2\ SO_4$ was added to digest the sample for 30minutes under reflux. It was filtered residue with a cloth (calico) and washed to litmus paper. The residue was transferred into a conical

flask and digested with 200ml of 2N sodium hydroxide (NaOH) under reflux for another 30minutes. The transferred was filtered and washed with boiling water until the residue was filtered and washed with boiling water until the washing become neutral to litmus paper. The residue was transferred to a crucible of known weight and dried in the weight. The dried residue was placed in a muffle furnace for three hours (3hrs) at 600^{o}C, cooled in a dessicator and the final weight taken. The wendel method described by James (1995) was used for the crude fibre determination.

The percentage crude fibre was calculated as shown below:

$$\% \text{ crude fibre} = \frac{\textbf{loss in weight x 100}}{\textbf{Weight of sample}}$$

Determination of Fat Content

This was determined by the solvent either extraction method in a continuous reflux system using the soxhlet apparatus.3.0g of the sample was dried wrapped in a filter paper and place in a soxhlet extractor. 200ml of petroleum ether was poured in to distillation flask which has been previously dried & weighed. The soxhlet extractor with reflux condenser was mounted on the flask and connected to the condenser. The flask was heated in an electro thermal heating mantle. As the soxhlet boiled, it vapoured and condensed into the soxhlet reflux extractor, conveying the sample and extracting the oil as the solvent boiled gently, the system was left to siphon over at least seventeen times after 4 hours extraction under reflux, the defatted sample contained in the flask was brought out with the aid of forceps and dried in the oven at 60^{o} for 30minutes. The petroleum ether was recovered by evaporation and condensation process. The flask containing the oil was dried in the oven at a temperature of 100^{o}C and the extracted fat weighed.

The percentage fat content was calculated thus

$$\% \text{ fat} = \frac{\textbf{weight of extracted fat x 100}}{\textbf{weight of the sample} \quad \textbf{1}}$$

Determination of Carbohydrate Content

This was calculated by sample difference (James, 1993)

% carbohydrate = 100 (sum of % fat, protein, ash, moisture & crude fibre).

EVAULATION OF FUNCTIONAL PROPERTIES

1. **Swelling Index :**
   Swelling index was calculated using the method of Ukpai and Ndumele (1996). 10 (ten) grams of the processed sample was weighed and dispersed into 100ml measuring. Level and the volume noted. Distilled water was added to help the cylinder and allowed to stand for 1 hour. The volume was then recorded and the swelling index calculated as the ratio of the volume to the initial volume.
   $$\mathbf{S = V_2 / V_1}$$
   Where
   S = Swelling Index
   V_1 Initial Volume
   V_2 Final Volume
2. **Water Absorption Capacity (WAC):**
   This was determined as the water absorbed and held by one gramme of sample (Okaka and Potter, 1997). One gramme of the sample was weighed and put into weighed test tube. Ten ml of distilled water was added to the test tube and mixed very well. The mixture was allowed to stand for 30minutes at room temperature. The mixture was centrifuged at 3500 rpm for 30minutes. The supernatant was decanted and the residue in the test tube was inverted over an absorbent paper (tissue pad). It was allowed to drain/dry completely before the tube and its content was weighed. By difference the weight of water absorbed and held by the sample was obtained.
   It was calculated as shown below:
   $$\textbf{Water absorption capacity} = \frac{\mathbf{W_2 - W_1}}{\mathbf{W}}$$
   Where

W = weight of sample
W_1 = weight of empty tube
W_2 = weight of tube + water absorbed

3. **Bulk Density (BD):**
   The method of Onwuka (2005) was used. Ten grams of each sample was measured into clean 100ml graduated measuring cylinder and its volume was recorded in each case. Then in each case, the bottom of the cylinder was tapped repeatedly on a padded table until no further reduction was seen in volume. Its volume was recorded as the packed volume. The bulk density was calculated for both th e loose and packed version using the general formula below:

$$\text{Bulk density } (g/\ cm^3) = B.D = \frac{\text{weight of sample (g)}}{\text{Volume occupied (cm)}}$$

Result
Analysis of variance (ANOVA) was carried out at 0.05 level to determine the difference among the samples using one factor randomized design. ANOVA as described by O' Mahonny (1986) and the fisher`s least significance difference (LSD) test were used.

Summary and Findings
Description of procedures used: We used processed sorghum, corn rice into flour. Sorghum known to contain high amount of carbohydrate. Weaning food was made using high level of composite flours. Proximate composition & functional properties of weaning food made were carried out to determine the nutrient content of the produce. The samples were subjected to sensory evaluation for such attributes as colour, texture, taste, flavour and general acceptability.

1. Weaning food made from the blend of rice, sorghum and maize flour have high food potential and could be used by families to reduce protein energy malnutrition (PEM).
2. Composite flour can replace 10% wheat flour in weaning food.
3. Families can improve their menu as local foods can be used in diversified diets.
4. The study will be resourceful to the students of economics who carry out research on food predevelopment using local foods.
5. However, the quality attributers decrease with increase in the level of rice flour with respect to taste and flavour.
6. Quality weaning food was made from composite flour, result for approximate composition showed that the carbohydrate content increased with increased addition of rice flour.
7. Sample C (40, 30 30) was described by the panelist to have good taste & flavour due to reduce addition of rice flour.

Conclusion
This study attempted to formulate a weaning food that will be of higher nutritive value & easily affordable. The result shows that acceptable low cost weaning food could be produced from a combination of rice, sorghum and corn flour. Weaning was formulated from locally available flour of cereal grains such as rice, sorghum and corn flour using household technologies like blending. The proximate composition of these weaning food fortified with 10% skimmed milk powder contained higher amount of protein and other nutrients. Results also showed that reduce addition of rice flour increase the taste, colour and aroma of the weaning food. Sorghum and corn flour fortification was considered the best because it is attractive has a good aroma and generally accepted. The total energy expressed in terms of local per 100g of product varied from 360.7 to 418.8.The various minerals viz: calcium phosphorous and iron was found to increase on supplementation with glucose 10% skimmed milk powder. Shelf life of the weaning food was good in air tight container.

Recommendation
It is recommended that weaning food gruel be fed to infants aged 6 months and above. The weaning food should also be taken with a good quantity of infant milk & less quantity of sugar & honey. Based on the findings of this study, the problem encountered, it is therefore recommended that:

1. Popularizing the use of these flour blends will go a long way to reduce the country`s dependency on commercial weaning food thereby saving scare and foreign exchange.

2. Rice, sorghum and corn flour can find useful affluence for products for which commercial weaning food has been used.
3. Substituting up 10% of rice, sorghum, corn flour with soybean flour will enhance its nutritional composition.

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